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Mixtures of Spring Cereals and Flax in Ohio

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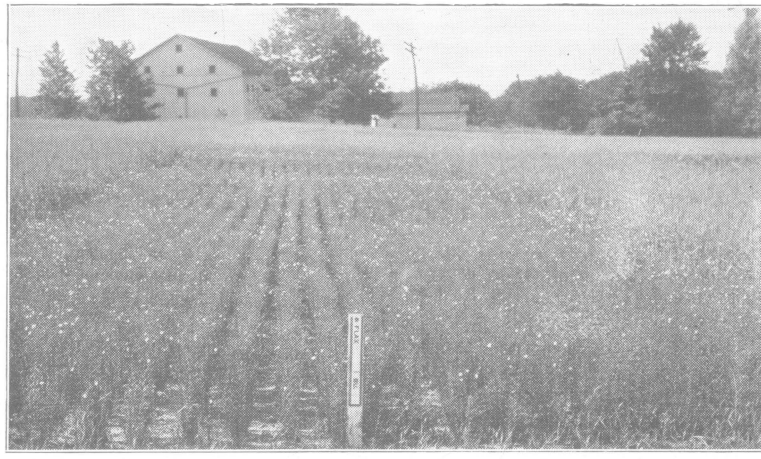

Fig. 1.—Test plots at Wooster showing flax at center

MIXTURES OF SPRING CEREALS AND FLAX IN OHIO

L. E. THATCHER

SUMMARY

Oderbrucker barley, Fulghum oats, Linota flax, and Marquis spring wheat were grown separately and in mixtures for five years at Wooster.

YIELDS

Oats at a uniform rate of one bushel per acre were grown with flax at one-fourth, one-half, and three-fourths bushel per acre. The flax seed yields increased with the rate of seeding the flax and the yields of oats decreased.

The relative yields of the various crops ranked in the following order: Oats 100, barley-flax 88.9, barley-oats 88.3, barley 84.3, oats-flax 77.5, barley-spring wheat 68.6, spring wheat 65.7, oats-spring wheat 64.7, spring wheat-flax 60.6, and flax 43.8.

Oats have outyielded barley on a pound per acre basis in numerous tests on the ten outlying experimental farms of the State. The ratio of barley to oats ranged from 46.2 : 100 for Clermont County to 84.7 : 100 for Miami County.

Almost as much barley was grown when mixed with flax as when grown alone.

The yield of oats was reduced 31.3 percent when mixed with flax.

Apparently oats suffer more in competition with companion crops than does barley as shown by comparing the barley-flax, oats-flax, barley-spring wheat and oats-spring wheat mixtures.

More flax was grown with oats than with barley or spring wheat.

The yield of the barley-oats mixture, most frequently considered by Ohio farmers, had no advantage over oats alone, or over equal areas of barley and oats grown separately. Three-fifths of the mixture was barley grain.

THE FEEDING VALUE PER ACRE

The feeding value of the crop was calculated from the digestible nutrients as given by Henry and Morrison.

The barley-flax mixture had the highest calculated feeding value, followed closely by oats alone, and its nutritive ratio was comparable to that of oats.

The barley-oats mixture was less desirable from the feeding standpoint than oats and but little better than barley.

Feeding trials with the barley-flax mixture will need to be completed before its practical value can be determined. Only 4.8 percent of the mixture was crude fibre as compared to 10.9 percent for oats. The danger of prussic acid poisoning from feeding whole or ground flax seed is pointed out.

THE MARKET VALUE

The five-year average December 1 Ohio farm prices for barley, oats, and wheat (winter), and the Wisconsin December 1 farm price for flax seed were used in calculating the money values of the crops.

The prices of the mixtures were calculated on the basis of the market value of the separated grains. Difficulties in the way of marketing the several mixtures and of flax seed in Ohio are pointed out.

The estimated value of the flax seed produced compared with that of barley, oats, and spring wheat in this test indicates that flax seed production in Ohio might be revived if marketing facilities were favorable.

The marked fluctuation in the yields of spring wheat in Ohio render it a very uncertain cash crop.

For a period of 17 years in another test at Wooster the yield of spring wheat was 16.7 bushels, barley 32.4 bushels, and oats 64.3 bushels. On the basis of the farm prices given, the farm values per acre for spring wheat have been $22.54, barley $23.33, and oats $28.93. Oats were more profitable than barley by $2.95 in the 5-year test and $5.60 in the 17-year test.

None of the mixtures except the barley-flax and spring wheat-flax were promising as cash crops, and of these the barley-flax is at present impracticable because of the difficulty of separating the mixture. The spring wheat-flax mixture could be encouraged if the local market for flax seed justified its culture.

The cash or money value of the nutrients in the crops shows that spring wheat is more profitable as a cash crop than as a feed crop and that it would have been slightly profitable to exchange oats for barley for feeding at the prices given.

Two diagrams are shown by which the relative feeding value of various quantities (bushels) of oats and barley can be calculated and whereby the relative cost of a unit of total digestible nutrients in barley as compared to oats can be found with the grains at various prices per bushel.

MIXTURES PROFITABLE IN NORTHERN STATES AND CANADA

The growing of various mixtures of the cereal crops and of cereals and flax has become a common practice in some of the northern states and in parts of Canada. In Canada[1] in 1926, the acreage of mixed grains was 770,981 acres, or about 13.7 percent of the total of 5,632,191 acres devoted to the eleven principal grain crops grown. The principal mixture in Canada is one of barley and oats, usually seeded at the rate of one bushel of each grain per acre. The mixed grain finds a ready market in Ontario, the value per acre averaging $25.73 for the 17-year period of 1909 to 1925, inclusive, compared to $19.01 for oats and $23.14 for barley.

In the spring wheat section of the United States the most common mixture is one of spring wheat and flax. Prof. A. C. Arny[2] reports that this has been a common mixture in Minnesota for over 40 years.

These combination crops have been grown to advantage in the northern sections of the country, and this fact has been brought to the attention of Ohio farmers largely by the farm press. As a result, many farmers have considered growing some of these mixtures in Ohio, and have sought advice from the Ohio Station. This publication gives the results of experiments in which various cereal and flax mixtures were grown on the main station farm at Wooster from 1923 to 1927, inclusive.

Oderbrucker barley and Fulghum oats, varieties that mature at nearly the same time at Wooster, and Linota flax and Marquis spring wheat were selected for this test.

The yields.—In Table 1 are given the crops, the rate of seeding, the yield of grain and straw per acre, the percentage of each grain in the mixture harvested, and the relative yields of grain and straw, taking the yield of oats as 100 for comparison.

The rates of seeding.—The rates of seeding for the grain grown separately are those normally giving maximum yields, with the possible exception of oats which was seeded at 2 bushels per acre. The optimum rate of seeding oats at Wooster has been 11 pecks per acre for the past 22 years; the average yields for this rate being 55.6 bushels per acre compared with 54.1 bushels for the 2 bushel rate.

[1]Zavitz, C. A., Forty Years' Experiments with grain crops. Ontario Dept. of Agr. Bul, 332—1927.

[2]Arny, A. C., Wheat and Flax as Combination Crops. Minn. Agr. Exp. Sta. Bul. 204—1923.

In the present test oats seeded at 2 bushels per acre outyielded the other grains; increasing the rate to 11 pecks might have made the difference even more favorable to oats.

Varying the amount of flax seed.—For two years, 1923 and 1924, flax was seeded alone at the rate of ½ bushel per acre and in mixtures at ¼ bushel. In 1925, 1926, and 1927 the rate was increased to ¾ bushel seeded alone and to ½ bushel in the mixtures.

TABLE 1.—Flax and Cereal Mixtures, Grown on the Station Farm, Wooster, Ohio—5-year average, 1923-27

Crop and rate seeded per acre		Grain per acre				Straw	Relative yield lb. per acre basis Oats=100	
		Each crop			Total		Grain	Straw
	Bu.	*Lb.*	*Pct.*	*Bu.*	*Lb.*	*Lb.*	*Pct.*	*Pct.*
Barley	2	1746	100.0	36.37	1746	2365	84.3	87.4
Oats	2	2072	100.0	64.75	2072	2705	100.0	100.0
Spring wheat	2	1361	100.0	22.68	1361	2678	65.7	99.0
Flax*	½ or ¾	908	100.0	16.21	908	2352	43.8	86.9
Barley	1	1097	59.9	22.85	1831	2513	52.9 } 88.3	92.9
Oats	1	734	40.1	22.94			35.4 }	
Barley	1	825	58 0	17.19	1422	2293	39.8 } 68.6	84.8
Spring wheat	1	597	42.0	9.95			28.8 }	
Oats†	1	659	49.1	20.59	1342	1929	31.8 } 64.7	73.1
Spring wheat	1	683	50.9	11.38			32.9 }	
Oats	1	1424	88.6	44.50	1607	2428	68.7 } 77.5	89.8
Flax‡	¼ or ½	183	11.4	3.27			8.8 }	
Barley	1	1709	92 8	35.60	1841	2425	87.5 } 93.9	89.6
Flax‡	¼ or ½	132	7.2	2.36			6.4 }	
Spring wheat	1	1091	86.9	18.18	1256	2513	52.6 } 60.6	92.9
Flax‡	¼ or ½	165	13.1	2.95			8.0 }	

*½ bu. 2 years and ¾ bu. 3 years.
†4 years only.
‡¼ bu. 2 years and ½ bu. 3 years.

The effect of varying the amount of flax seed used with oats is shown by the results of two years' test in which the rates for flax were ¼, ½, and ¾ bushel per acre with 1 bushel of oats.

Increasing the amount of flax in the seed mixture increased the amount of flax in the crop harvested both in pounds per acre and percentage in the mixtures as shown in Table 2.

The yield of oats was reduced as the amount of flax was increased.

Ratios vary from year to year.—The proportion of flax in the mixture harvested varied from year to year. In the mixture of oats 1 bushel and flax ¼ bushel, which was grown thruout the five-year period, the percentage of flax in the mixture harvested was as

follows: 1923, 3.4%; 1924, 18.0%; 1925, 9.5%; 1926, 12.3% and 1927, 9.3%. When growing conditions favored the cereal crop, there was less flax in the mixture.

TABLE 2.—Oats and Flax at Three Rates for Flax, Wooster, 1926 and 1927

Crop	Rate per acre	Yield per acre			
		Each grain	Total grain	Total straw	Grain in mixture
	Bu.	*Lb.*	*Lb.*	*Lb.*	*Pct.*
Oats	1	1307	.....	.....	88.9
Flax	¼	163	1470	1932	11.1
Oats	1	1205	.....	.....	83.8
Flax	½	232	1437	1870	16.2
Oats	1	1081	.....	.....	77.6
Flax	¾	312	1393	1876	22.4
Oats	2	1959	1956	2766	100
Flax	¾	846	846	1810	100

The yield of oats was reduced as the amount of flax was increased.

When the cereal-flax mixtures are grown for feed in Ohio, the amount of flax seed sown should not be less than ¼ bushel nor more than ½ bushel per acre with about one-half the regular rate of seeding for the cereal crop. Too large a percentage of flax seed in the mixture harvested may be objectionable from the feeding standpoint, 10 percent probably being as high as it is safe to feed. This is discussed more fully under "Barley-flax mixture for feeding," on page 10.

The yields.—Referring to the yields of the several grain crops grown separately (Table 1) it is noted that oats gave the highest yield of grain and straw. Barley alone compared to oats yielded 84.3% as much grain and 87.4% as much straw; spring wheat, 65.7% as much grain and 99.0% as much straw; and flax, 43.8% as much grain and 86.9% as much as straw. Weeds were not troublesome on these plots and even the flax, which is likely to have more weeds in it than other crops, was comparatively free from weeds.

Oats outyield barley.—The tendency for oats to outyield barley in Ohio is illustrated by the yields secured in the county and district experiment farms scattered over the State. These results are given in Table 3, in which Miami oats and Oderbrucker barley are compared.

Spring wheat was also grown for a part of the time in these tests and gave a grain yield of 46.3 percent as much as oats.[3]

[3]45th Annual Report of the Ohio Agr. Exp. Sta. Bul. 402—1927.

Yields of mixtures.—Taking up next the combination crops in Table 1, we find the mixture of barley and oats yielding more grain than any other combination of cereals, and exceeded only slightly by the barley and flax mixture. Unless the barley-oats mixture has some advantage from the feeding standpoint which is not now apparent there is no good reason for growing it in preference to oats alone. Three-fifths of the mixture was barley grain. The barley-spring wheat and oats-spring wheat mixtures yielded much lower than oats alone.

TABLE 3.—Oderbrucker Barley and Miami Oats, Yield and Ratio of Barley to Oats on Experiment Farms in Ohio

County	Years averaged	Average yield		Ratio of barley to oats (pound-per-acre basis) Oats=100
		Barley	Oats	
	No.	*Bu.*	*Bu.*	*Pct.*
Miami	12	36.55	64.69	84.7
Paulding	12	29.42	56.14	78.6
Hancock	10	25.28	47.47	80.0
Belmont	10	28.48	57.21	74.7
Meigs	9	17.87	35.27	76.0
Hamilton	13	21.40	44.92	71.5
Madison	9	26.59	55.30	72.1
Trumbull	8	24.89	53.29	70.0
Wayne	18	31.04	69.96	66.5
Mahoning	10	26.66	60.76	65.8
Clermont	7	9.43	30.61	46.2

The cereal and flax mixtures offer some interesting comparisons. Almost as much barley was grown in the barley-flax mixture as when barley was grown alone. On the other hand the yield of oats in the oats-flax mixture was reduced 31.3 percent over oats alone. More flax was grown with oats, however, than with barley. Apparently oats suffers more in competition with companion crops than does barley. This is also illustrated in the barley-spring wheat and oats-spring wheat mixtures. The yield of flax mixed with spring wheat, 165 pounds, was about midway between the yield with oats and barley.

THE FEEDING VALUE

Calculating the feeding value.—Most Ohio farmers who have grown the mixtures have had in mind feeding the mixed grain on the farm. This discussion of the relative feeding value of the several crops is based on the digestible nutrients contained in the crops as given by Henry and Morrison.[4] The following table of digestible nutrients was used.

[4]Henry and Morrison, Feeds and Feeding, 18th Edition, 1923.

In calculating the total column, the pounds of fat are multiplied by 2.25 to convert them to carbohydrate equivalents.

TABLE 4.—Digestible Nutrients in 100 Pounds of Grain

	Crude protein	Carbohydrates	Fat	Total
	Lb.	*Lb.*	*Lb.*	*Lb.*
Barley	9.0	66.8	1.6	79.4
Oats	9.7	52.1	3.8	70.4
Spring wheat	9.2	67.2	1.6	80.0
Flax	20.6	17.0	29.0	102.8

In calculating the total column, the pounds of fat are multiplied by 2.25 to convert them to carbohydrate equivalents.

Table 5 gives the total digestible nutrients per acre for the several crops.

Barley-flax equals oats.—The barley-flax mixture had the highest calculated feeding value, oats alone second. The difference in favor of the mixture was only 33 pounds of total digestible nutrients per acre and was scarcely significant. It is to be noted, however, that the addition of flax to the barley increased the digestible protein and fat in the mixture over barley alone, making the nutritve ratio comparable to oats alone. The mixture of oats

TABLE 5.—Flax and Cereal Mixtures, Five-year Average Yield of Crude Digestible Nutrients per Acre

Crop	Seed per acre	Grain per acre		Digestible nutrients per acre			
		Each crop	Total	Crude protein	Carbo-hydrates	Fat	Total
	Bu.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Barley	2	1746	1746	157.0	1166.0	28.0	1386
Oats	2	2072	2072	201.0	1080.0	79.0	1459
Spring wheat	2	1361	1361	125.0	915.0	22.0	1089
Flax	½ or ¾	908	908	187.0	154.0	263.0	933
Barley	1	1097	1831	98.7	733.0	17.5	871
Oats	1	734		71.2	392.0	27.8	517
Total				169.9	1115.0	45.3	1388
Barley	1	825	1422	74.2	551.0	13.2	655
Spring wheat	1	597		54.9	401.0	9.5	477
Total				129.1	952.0	22.7	1132
Oats	1	659	1342	63.9	343.0	25.0	464
Spring wheat	1	683		62.8	459.0	10.9	546
Total				126.7	802.0	35.9	1010
Oats	1	1424	1607	138.1	742.0	54.1	1002
Flax	¼ and ½	183		37.7	31.0	53.0	188
Total				175.8	773.0	107.1	1190
Barley	1	1709	1841	154.0	1141.0	27.3	1356
Flax	¼ or ½	132		27.2	22.4	38.3	136
Total				181.2	1163.4	65.6	1492
Spring wheat	1	1091	1256	100.4	733.0	17.4	873
Flax	¼ or ½	165		34.0	28.0	47.8	169
Total				134.4	761.0	65.2	1042

and flax produced less digestible nutrients than barley and flax due to the reduction in the yield of oats when mixed with flax. From the nutritive standpoint, spring wheat did not compare favorably with either oats or barley or the oats-flax and barley-flax mixtures.

The barley-oats mixture, which is the one most frequently considered by Ohio farmers, offers little encouragement from the feeding standpoint, being somewhat less desirable than oats alone and but little better than barley alone. The barley-spring wheat and oats-spring wheat mixtures are too low in feeding value per acre to be given any consideration.

Barley-flax mixture for feeding.—The barley-flax mixture, however, may have some practical value from the feeding standpoint. Feeding trials now under way will help to clear up this point. On the basis of calculated total digestible nutrients per acre it has been a little better than oats, or at least equal to oats. It may have some advantage over oats for certain classes of livestock because of the smaller amount of crude fibre contained and the slightly laxative effect of the flax seed in the mixture. Only 4.8 percent of the mixture was crude fibre as compared to 10.9 percent for oats.

It should be noted that flax seed cannot be added to a grain ration in sufficient quantities to balance the ration with protein in the same way that oil meal is used. Little is known as to the upper limit of safety in this regard, but it seems that to be on the safe side it should not constitute more than 10 percent of the entire grain ration. Feeding trials will be needed to answer the question.

Danger of feeding flax seed.—For the benefit of those who may be tempted to try feeding flax seed on the farm it may be well to point out the fact that ground flax seed sometimes develops a poisonous property, prussic acid, which is very poisonous to horses, cattle, and sheep. Hogs are more tolerant to the poison and apparently are not injured by amounts that severely affect cattle and sheep. When whole or ground flax seed is fed to calves, a practice that is common in some sections, the seed, or meal, is treated with boiling water. The heat kills the enzyme which causes the poison to develop. Commercial flax seed meal or oil meal is safe to feed to all classes of livestock because the heat used at the time of pressing the oil from the seed destroys the prussic acid forming enzyme.

Value of straw.—Farmers who make a practice of selling straw will need to keep in mind the fact that the straw from a cereal-flax

mixture cannot be used in certain manufacturing processes where pure cereal straw is used. For use for bedding livestock and for litter, the presence of some flax straw is not objectionable.

THE MARKET VALUE

Prices used.—The market value of the crops grown in the test is based on the December 1 Ohio farm price for barley, oats, and winter wheat and on the Wisconsin December 1 farm price for flax seed (Table 6), and for the five-year period covered by the test.

TABLE 6.—State Average Farm Price of Ohio Barley, Oats, and Wheat (Winter) and for Wisconsin in Flax Seed

Date	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	Barley, cents per bushel											
1923	64	66	66	68	68	66	63	62	60	60	62	66
1924	64	69	67	65	66	63	68	70	75	80	80	90
1925	96	98	100	100	91	90	85	75	75	71	70	70
1926	75	71	67	67	68	69	65	61	58	61	60	60
1927	59	63	62	65	66	68	67	63	69	75	71	73
Average	72	73	72	73	72	71	70	66	67	69	69	72
	Oats, cents per bushel											
1923	47	48	50	53	54	52	47	44	44	45	45	45
1924	44	47	47	46	46	45	50	48	47	49	50	53
1925	58	56	53	48	50	51	49	41	39	37	38	40
1926	42	41	41	41	41	41	40	38	32	38	39	40
1927	42	42	41	42	44	46	45	42	43	45	45	48
Average	47	47	46	46	47	47	46	43	41	43	43	45
	Wheat (winter), dollars per bushel											
1923	1.24	1.23	1.21	1.22	1.24	1.22	1.08	0.91	0.93	0.98	1.02	0.99
1924	1.03	1.05	1.04	1.00	1.06	1.04	1.10	1.22	1.21	1.33	1.46	1.56
1925	1.82	1.88	1.78	1.59	1.71	1.73	1.52	1.55	1.55	1.49	1.56	1.67
1926	1.75	1.74	1.65	1.59	1.59	1.45	1.32	1.23	1.21	1.24	1.29	1.29
1927	1.28	1.27	1.25	1.20	1.27	1.32	1.30	1.25	1.24	1.26	1.25	1.28
Average	1.42	1.44	1.39	1.32	1.37	1.35	1.26	1.23	1.22	1.26	1.31	1.35
	Flax (Wis.), dollars per bushel											
1923	2.08	2.10	2.20	2.20	2.20	2.15	2.05	2.10	2.22	2.12	2.05	2.26
1924	2.20	2.20	2.20	2.10	2.10	2.20	2.20	2.18	2.10	2.18	2.10	2.10
1925	2.60	2.70	2.60	2.40	2.50	2.54	2.40	2.10	2.00	2.10	2.29	2.37
1926	2.14	2.25	2.01	2.00	2.00	1.98	2.10	2.18	2.08	1.99	1.91	1.96
1927	1.98	1.90	1.95	1.90	1.99	2.06	1.94	1.95	1.94	1.83	1.85	1.84
Average	2.20	2.23	2.19	2.12	2.15	2.19	2.14	2.10	2.07	2.04	2.04	2.10

Data supplied by J. I. Falconer, Department of Rural Economics.

Winter wheat prices used for spring wheat.—Since the production of spring wheat in Ohio is of little importance commercially and no price figures are available comparable to those for barley and

oats, the price for winter wheat is used instead. This is giving spring wheat an advantage because the quality of Ohio grown spring wheat in test weight per bushel is on the average, below that of winter wheat. At Wooster, a six-year average test weight per bushel was 58 pounds for Blue Ribbon spring wheat, one of the best in quality, and 61.4 pounds for Trumbull winter wheat. In Ohio the quality of spring wheat fluctuates from year to year to a greater degree than winter wheat. The bulk of spring wheat grown in Ohio is marketed in small lots to local elevators where it is accepted on the basis of winter wheat price and grade and is mixed with winter wheat when shipped to the terminal markets. Spring wheat grown in Ohio is generally softer in texture than northern grown spring wheat, approaching our harder local types of winter wheat. These factors should be considered in comparing the market value of spring wheat with the other grain crop.

Wisconsin flax price used.—The December 1 Wisconsin farm price was used for flax, since the production in Ohio is not sufficient to establish a local price. In Wisconsin, which is on the edge of the flax producing area in the northwest, the farm prices are four to five cents lower than in North Dakota, which is in the center of the flax area. The principal markets for flax seed are Minneapolis and Duluth, Minnesota. Crushing plants, however, are located at Toledo, Cleveland, and Buffalo. These plants would probably purchase Ohio grown flax seed in carload lots or less on the basis of the Minneapolis and Duluth markets, the price being determined largely by the difference in transportation charges and upon the quality of the seed delivered.

Oats and barley prices.—The Ohio farm prices for oats and barley are those for the entire state. These are a few cents higher than those in northwestern Ohio where the bulk of Ohio barley is grown. However, the relative prices for oats and barley are nearly the same in both cases. Table 7 was prepared on the basis of the prices discussed.

Calculated values.—Table 7 shows first the market value per acre for each crop grown separately and for the mixtures on the assumption that the mixed grains could have been marketed on the basis of the value of the separated grains. At the present time there is no market for the mixed grains in Ohio and their satisfactory separation is well nigh impossible in the case of the cereals and for the barley-flax and oats-flax mixtures.

Spring wheat and flax can be separated fairly satisfactorily. However, the valuations given for the mixtures enable us to arrive at some estimation of their replacement value in terms of the pure grains.

TABLE 7.—Flax and Cereal Mixtures, Farm Market Value per Acre and Value of 100 Pounds of Total Digestible Nutrients in the Crop—Five-year Average

Crop	Seed per acre	Yield per acre	Farm value per acre Dec. 1	Value of 100 lb. total digestible nutrients in crop
	Bu.	*Bu.*	*Dol.*	*Dol.*
Barley	2	36.37	26.19	1.89
Oats	2	64.75	29.14	2.00
Spring wheat	2	22.68	30.62	2.81
Flax	½ or ¾	16.21	34.04	3.65
Barley	1	22.85	16.45	
Oats	1	22.94	10.32	
Total		45.79	26.77	1.93
Barley	1	17.19	12.38	
Spring wheat	1	9.95	13.43	
Total		27.14	25.81	2.28
Oats	1	20.59	9.26	
Spring wheat	1	11.38	15.37	
Total		31.97	24.63	2.43
Oats	1	44.50	20.02	
Flax	½ or ¼	3.27	6.86	
Total		47.77	26.88	2.26
Barley	1	35.60	25.63	
Flax	½ or ¼	2.36	4.95	
Total		37.96	30.58	2.05
Spring wheat	1	18.18	24.55	
Flax	½ or ¼	2.95	6.19	
Total		21.13	30.74	2.95

Five-year average farm prices per bushel December 1: Barley 72 cents, Oats 45 cents, Wheat $1.35, and Flax $2.10.

Acre value of pure grains.—The annual acre value of the pure grains for the 5-year period ranked in the following order: Flax $34.04, spring wheat $30.62, oats $29.14, and barley $26.19.

Possibilities of flax seed as an Ohio crop.—The practical aspects of these figures will be discussed in the same order. Reference has already been made to the lack of marketing facilities for flax seed in Ohio. A realization of returns by Ohio farmers comparable to that calculated for flax in Table 7, will depend upon the future development of the industry in Ohio. That the yields of flax seed grown in Ohio are comparable to yields secured in the north central states is indicated by the 5-year average of 16.2 bushels at Wooster and by the 3-year average of 8.7 bushels on the Paulding County Experiment Farm with five varieties. The

average yield per acre for the United States for the period of 1921-1925 was 8.3 bushels. Ohio at one time was a large producer of flax seed; 75 years ago the center of the industry was in Ohio and Kentucky. The industry was driven out of Ohio with the opening up of new land in the north central states where the crop could be grown much cheaper and also because flax diseases became prevalent in Ohio on the older flax producing land, making its production unprofitable. Disease resistant strains of flax have been developed in the north central states and seed of some of these is available.

Flax seed production might be revived in Ohio if marketing facilities were favorable. However, two factors should be considered. First, the fact that the flax acreage in the north central states is capable of considerable expansion; second, flax seed enjoys a tariff protection of 40 cents per bushel. An increase of 25 percent in the Minnesota flax acreage for 1928 is being attempted by the extension forces of the Minnesota College of Agriculture. Over production would soon bring down the price. Should the tariff be lowered or removed some reduction in the domestic price could be expected.

On the whole, it seems wise for Ohio farmers to go slow in increasing the acreage in this State. Should the consumption of flax seed continue to increase in the United States, keeping the domestic market on a stable basis, there is no reason apparent from the agronomic standpoint why Ohio farmers could not safely engage in its production.

SPRING WHEAT UNCERTAIN CROP

During the period of the test, spring wheat was more profitable than oats or barley. The yield of 22.68 bushels is high, compared with previous 5-year periods at Wooster. This happened to be a good period for spring wheat. Perhaps a better measure of the relative standing of spring wheat, oats, and barley can be secured by taking a longer period of years in which they have been grown in comparison as shown by Table 8.

TABLE 8.—Average Yield of Spring Wheat, Barley, and Oats at Wooster for a 17-year Period

	Yield per acre	Farm value per acre
Spring wheat	16.7 bushels	$22.54
Barley	32.4 bushels	23.33
Oats	64.3 bushels	28.93

The yield of spring wheat fluctuates from season to season to a greater degree than that of barley or oats. At Wooster in the 17-year period it ranged from a total failure in 1915 to 27.8 bushels in 1923. The average of all fluctuations from the average yield was 44 percent, whereas, barley fluctuated 29 percent and oats 19 percent during the same period.

Oats more profitable than barley.—As a cash crop, oats were more profitable than barley in this test, the acre return on the average being $2.95 in favor of oats. In the 17-year test the difference was $5.60 per acre in favor of oats.

No advantage in mixtures as cash crops.--None of the mixtures except the barley-flax and spring-flax were sufficiently outstanding to warrant their production as cash crops. The difficulty of separating the barley-flax mixture makes it impracticable as a cash crop at the present time. The spring wheat-flax mixture is the only one that offers any encouragement, should the market for flax seed justify its culture.

Value of nutrients in each crop.—The last column in Table 7 shows the value of 100 pounds of total digestible nutrients in each crop at the price given for the crop. It is obvious that it would be more profitable to sell spring wheat than to feed it on the farm and that it would be slightly profitable to exchange oats for barley for feeding, the class of livestock to be fed being taken into consideration.

CALCULATING THE RELATIVE FEEDING VALUE OF DIFFERENT QUANTITIES (BUSHELS) OF OATS AND BARLEY

It is sometimes desirable to be able to determine quickly the relative feeding value of various quantities of oats and barley, for example, an acre of barley and of oats, or the nutrients to be secured in each for a given sum of money.

The diagram (Fig. 2, Part 1) may be used for determining approximately whether any quantity of barley in bushels contains more or less total digestible nutrients than a given quantity of oats. To illustrate: Suppose it is desired to compare the relative feeding value of a yield of 42 bushels of barley and 60 bushels of oats. First divide the yield of barley by the yield of oats and express as percent thus

$$\frac{42}{60} \times \frac{100}{1} = 70$$

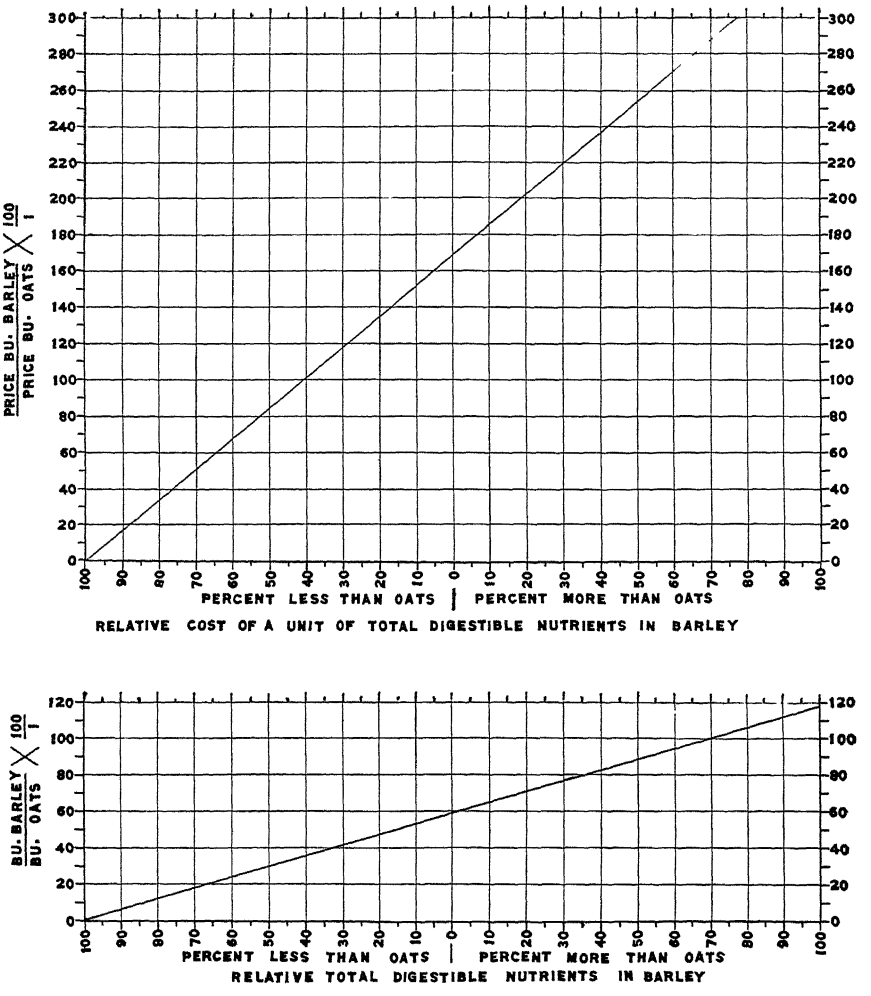

Fig. 2.—Use Part 1, above, in calculating the relative cost of a unit total digestible nutrients in barley. Use Part 2, below, in calculating total digestible nutrients in barley.

Read the percent directly underneath the point where the diagonal line crosses the horizontal line thru 70. The answer is 18.4 percent, or about one-fifth, more than oats. Therefore, 42 bushels of barley contains 18.4 percent more total digestible nutrients than 60 bushels of oats.

The same method is used if, for example, 42 bushels of barley or 60 bushels of oats can be purchased for the same money.

CALCULATING THE RELATIVE COST OF A UNIT OF TOTAL DIGESTIBLE NUTRIENTS IN BARLEY AND OATS AT DIFFERENT PRICES PER BUSHEL

It is also desirable at times to know the relative cost or worth of nutrients in barley and in oats, with each grain at a certain price per bushel.

The diagram (Part 2) may be used to determine the approximate relationship. For example: With barley at 80 cents a bushel and oats at 40 cents, what will be the relative cost of a unit of total digestible nutrients in barley compared with a unit in oats? Divide the cost of barley by cost of oats and express as percent.

$$\frac{80}{40} \times \frac{100}{1} = 200$$

Proceed as in Part 1. The point on the percent scale directly under the point where the diagonal line crosses the 200 line is a little less than 20 percent (18.2) more. Therefore at the prices quoted, a unit of digestible nutrients in barley will cost nearly 20 prcent more than in oats. Barley is a cheaper feed than oats until the price of barley is 69 percent more than that of oats or 169 on the scale.

These calculations have been made for average oats and barley. Allowance must be made for any marked difference in quality of the two grains.